2000A CIRCUIT BREAKER

1. **SCOPE**. This document provides technical specifications for the procurement of a 2000A low voltage power circuit breaker in a portable enclosure for temporary service use.

2. **APPLICABLE REFERENCES**. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids shall apply.

ASTM B 187-B 187M-03	- Standard Specification for Copper Bar, Bus Bar, Rod and Shapes
UL 50	- Enclosures for Electrical Equipment
UL 746B	- Polymeric Materials - Long Term Property Evaluations
UL 746C	- Polymeric Materials - Use in Electrical Equipment Evaluations
UL 891	- Dead Front Switchboards
MIL-C-5541	- Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-A-8625	- Anodic Coatings for Aluminum and Aluminum Alloys

3. **REQUIREMENTS.**

3.1 GENERAL REQUIREMENTS.

3.1.1 NEW DEVELOPMENT. If, during the contraction period, any new developments are generated that would improve the efficiency, accuracy or productivity of the equipment and its related equipment or decrease its operation cots, the contractor shall notify the Contracting Officer. Reports of such developments shall be addressed to the Contracting Officer.

3.1.2 SAFETY AND HEATH REQUIREMENTS. Covers, guards, or other safety devices shall be provided for all parts of equipment that present safety hazards. Safety devices shall not interfere with operation of the equipment. The devices shall prevent unintentional contact with the guarded part and shall be removable to facilitate inspection, maintenance and repair of the parts. Machine parts, components, mechanisms, and assemblies furnished on the unit shall comply with all specific requirements of "OSHA Safety and Health Standards (29 CFR 1910), General Industry" that are applicable to the equipment itself. Additional safety and health requirements shall be as specified in other paragraphs of this specification. The design and manufacture shall be in accordance with all applicable OSHA safety standards.

3.1.3 OSHA APPROVED CERTIFICATION. The equipment installation and its component parts shall be in compliance with the applicable OSHA regulations in accordance with CFR Title 29, Chapter XVII, Part 1910 and installed in accordance with NEC/NFPA requirements. Approval shall be as specified under the “Approval” and “Acceptance” criteria in the OSHA regulations Subpart “O”, Machinery and Machine Guarding paragraph 1910.212 and Subpart “S” Electrical, paragraph 1910.303 and paragraph 1910.399. After equipment delivery, and prior to testing, the contractor shall provide an OSHA Certification Report. Failure to provide this certification report will delay acceptance of the equipment, and could result in rejection for failure to comply with the terms of the contract. This report documents the results of all tests performed, provides an assessment of the equipment performance for compliance with the contract requirements, and forms a basis for recommending a safety certification. The report, test and evaluation shall be a composite of those inspection requirements specified in the contract. The report shall be prepared in an orderly manner to clearly and accurately set forth the collected data and conclusion resulting from these inspection requirements, opinions and subjective conclusions shall be clearly identified.

The report shall include, but is not limited to, the following:

1. List of all tests performed and by whom witnessed.
2. List of data used for evaluation.
3. Tabulation of all discrepancies related to specification performance requirements.
4. Description of limitations revealed by data utilized.
5. Actions taken to mitigate each discrepancy and limitation.
6. Recommendations for subsequent actions.
7. Summary conclusions.
8. Manufacturer Certification that equipment has been manufactured and installed to OSHA CFR 1910.399 (per definition of "acceptable").

3.2 MATERIALS

3.2.1 FERROUS PARTS. All exposed ferrous parts such as screws, bolts, nuts, washers, etc., shall be chrome plated, galvanized or otherwise surface protected by an electrical/chemical process or of stainless steel to resist corrosion in a salt-laden moist, variable temperature environment.

3.2.2 ALUMINUM PARTS. All aluminum parts for use outdoors shall be anodized in accordance with MIL-I-8625 or chemically treated in accordance with MIL-C-5541, followed by two coats of weather-resistant exterior paint.

3.2.3 DISSIMILAR METALS. Intimate contact between dissimilar metals which can be expected to cause galvanic corrosion shall be avoided as much as practicable. When such contact cannot be avoided, an interposing insulating material shall be provided to minimize the corrosion effect.

3.2.4 MERCURY RESTRICTION. The equipment shall neither contain mercury or mercury compounds nor be exposed to free mercury during manufacture.

3.2.5 ASBESTOS RESTRICTION. The use of asbestos and materials containing asbestos on or in the furnished equipment is prohibited.

3.2.6 POLYCHLORINATED BIPHENYL (PCB) RESTRICTION. The use of polychlorinated biphenyl on or in the equipment is prohibited.

3.2.7 CADMIUM RESTRICTION. The use of cadmium and materials containing cadmium on or in the furnished equipment is prohibited.

3.2.8 LITHIUM RESTRICTION. The use of lithium and materials containing lithium on or in the furnished equipment is prohibited.

3.2.9 METHYLENE CHLORIDE RESTRICTION. The use of methylene chloride and materials containing methylene chloride on or in the furnished equipment is prohibited.

3.2.10 LEAD RESTRICTION. The use of lead and materials containing lead on or in the furnished equipment is prohibited.

3.3 WORKMANSHIP

3.3.1 STEEL FABRICATION. The steel used in fabrication shall be free from kinks, sharp bends, and other conditions that would be deleterious to the finished product. Manufacturing processes shall not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes shall be done neatly and accurately. All bends shall be made by controlled means to ensure uniformity of size and shape.

3.3.2 BOLTED CONNECTIONS. Boltholes shall be accurately punched or drilled and shall have the burrs removed. Washers or lock washers shall be provided in accordance with good commercial practice, and all bolts, nuts, and screws shall be tight.

3.3.3 RIVETED CONNECTIONS. Rivets may be used for minor attachments (e.g., label plates). Rivets shall not be used for main structural support. Rivet holes shall be accurately punched or drilled and shall have the burrs removed. Rivets shall be driven with pressure tools and shall completely fill the holes. Rivet heads, when not countersunk or flattened, shall be of an approved shape and of uniform size for the same diameter of rivet. Rivet heads shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

3.3.4 WELDING. Welding procedures shall be in accordance with a nationally recognized welding code. The surface of parts to be welded shall be free from rust, scale, paint, grease, or other foreign matter. Welds shall be of sufficient size and shape to develop the full strength of the parts connected by the welds. Welds shall transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

3.4 ELECTRICAL DESIGN

3.4.1 GENERAL. Construction shall be per Supplement "B" to UL 891 except as otherwise specified herein. Breaker shall be operable without exposing the operator to energized components (dead front).

3.4.2 INSULATION. Insulation material shall provide the level of performance specified for direct and indirect support of live parts in UL 746C. Relative thermal index of insulation per UL 746B shall be at least 130 deg C electrical and 130 deg C mechanical. A front safety barrier of insulating material shall be provided over ends of bus work otherwise exposed when the front doors are open.

3.4.3 CIRCUIT BREAKER. The main circuit breaker shall be rated at 2000A, 500VAC (minimum), 3 phase. The breaker shall have, at a minimum, integral long time (i2t) and instantaneous overcurrent trip capabilities. If the breaker is provided with a ground fault trip capability, it shall be capable of being disabled. The long time trip setpoint shall be adjustable between 800A and 2000A. The breaker shall be capable of withstanding and interrupting a short circuit current of 100,000 amperes RMS symmetrical. The breaker shall provide a shunt trip function. The breaker shall be listed and labeled by a Nationally Recognized Testing Laboratory (e.g. UL).

3.4.4 LOCKOUT REQUIREMENTS. A physical means shall be provided to prevent energization of the AC output bus bars, such that the equipment can be locked out for energy control purposes using a standard padlock. This isolation means shall mechanically prevent energization. The main circuit breaker designed with a lockout may be used as the lockout device.

3.4.5 BUS BARS. Bus bars shall be copper per ASTM B 187-B 187M-03. One bus bar shall be provided for each of the three (3) phases on the input and output sides of the circuit breaker (total of six (6) bus bars). Neutral bus bar(s) are not required and, if provided, shall be removable. Bus bars shall be suitable for continuous operation at 2000 amps. Operating temperature of the bus bars shall not exceed 90 deg C with a 40 deg C ambient temperature. Bus bars shall be drilled to accommodate lugs as shown in Figure 1; a minimum of three (3) sets of holes are required on each bus bar. The bending of bars shall not result in visible cracks, but roughening or slight surface crazing is acceptable. Bus bar spacing shall be per Figure 1.

3.4.6 BUS BAR SUPPORTS. Bus supports may be suitable non-conductive structural sections instead of the standoff type. Supports must meet the performance tests of section SB4 of UL 891. Bus bars and supports shall be designed and supported to withstand a short circuit current of 100,000 amperes RMS symmetrical. Bus and bus supports must also withstand the loads that would be produced by the weight of the installed cable and force of pulling on the cables at installation. Supports shall be designed to minimize dirt collection and to facilitate cleaning. Bus bar support system, including any I-beams, shall be expected to withstand operating temperatures of 90 deg C in a 40 deg C ambient environment. Bus bars, bus supports and associated supporting structural members shall be designed by a registered professional engineer.

3.4.7 GROUNDING. All exposed, non-current-carrying metal parts on the equipment shall be maintained at common, zero ground potential. Enclosure shall be provided with a steel grounding pad welded on or near the base of the enclosure. Pad shall be sized and installed for connection of a lugged 500 kcmil grounding cable. Pad shall be drilled for two 1/2-inch diameter bolts on 1-3/4 inch centers. All main doors shall have grounding straps across the hinged components such that the hinge is not relied upon for the grounding path.

3.4.8 AUXILIARY EQUIPMENT. All equipment required for proper operation of the circuit breaker (e.g. control power transformers, current transformers, etc.) shall be integral to the breaker or contained within the enclosure. No auxiliary equipment shall be connected between any of the main phases and earth ground. All auxiliary equipment connected to the main phases shall be protected by clearly labeled and accessible fuses or circuit breakers. No external control power shall be required.

3.4.9 REMOTE TRIP. An Amphenol Star-line series 7 pin receptacle with environmental cover using pins 2 and 5 for the remote trip contacts and pin 3 for ground shall be provided for connection of a remote trip device (Amphenol Star-Line series part number ZREP-12 12-310SN-03 or equivalent). The remote trip circuit shall trip the main circuit breaker upon closing of an external contact ("shunt trip"). The remote trip circuit shall be 120VAC (nominal) or less. The power source for the remote trip circuit shall be derived from the primary input power via an auxiliary step-down transformer built into the provided equipment.

3.4.9.1 Amphenol Star-line series 7 pin receptacle shall be accessible on the exterior of the equipment enclosure to allow for remote trip connection while maintaining a no category Arc Flash category for Personal Protection Equipment requirement.

3.5 MAIN ENCLOSURE. The requirements for the main enclosure are as follows:

3.5.1 MATERIAL. All components of the equipment shall be contained within one common enclosure. Surface shall be suitable for soap and water cleaning.

3.5.2 SIZE. The enclosure shall be of the minimum size that allows for adequate ventilation of components with dimensions no greater than a length of 5 feet, a width of 4 feet, and a height of 6 feet.

3.5.3 WEATHERPROOFING. The enclosure shall be NEMA 3RX rated or equivalent and shall maintain its NEMA 3RX rating when cables are connected to the input and output bus bars. The enclosure shall be of weatherproof construction to include flooring with appropriate drains installed. Additionally, the bottom of the enclosure shall be designed to prevent dust and moisture from ground water to be drawn inside. All openings to the interior of the transformer enclosure shall be adequately sealed to prevent entry by rodents (e.g. screens on all permanent openings).

3.5.4 CABLE ENTRY. Enclosure shall be capable of accepting a minimum 4 ea. 800 kcmil cables per phase on the line side and 5 ea. 800 kcmil cables per phase on the load side (i.e. 12 cables on the line side and 15 cables on the load side for a total of 27 cables) with adequate space for cable bend radius. Two 18 inch by 18 inch (minimum) areas located on opposite sides of the enclosure shall be left blank and clear (enclosure sheet metal only) for installation of cable entrances. Cable entrances will be cut out and installed by the end user. The highest point of each cable entrance area shall be lower than the lowest bus bar connection point. Cable entrance areas and bus bars shall be arranged so that a 16 inch (minimum) cable bend radius can be maintained with cables connected.

3.5.5 DOORS AND COVERS. The sides of the enclosure shall be fitted with hinged doors to permit full access to the installed equipment for routine inspection, in-place maintenance, trouble shooting, and removal of components. Door hinges and latches shall be of stainless steel construction and shall be conservatively sized to handle repeated use and stress. All hinges used in the construction of the enclosure shall be two piece split barrel, fixed pin, "bullet" type hinges. Hinges shall be attached to the enclosure by welding. A minimum of two (2) hinges shall be provided on each hinged access door or panel. Each door/cover shall be designed and equipped with appropriate gaskets/seals to protect the inside of the enclosure against the outside environment. Door gaskets/seals shall be robust and selected to survive repeated opening and shutting of doors.

3.5.6 TRANSPORTABILITY. The circuit breaker enclosure with installed equipment shall be designed to be safely lifted and transported without being trailer mounted. Vertical, horizontal, and cross bracing (as applicable) shall be of adequate size and thickness to withstand any reasonable stress that may be imposed when in transit as well as during normal operation.

3.5.7 LIFTING PROVISIONS. The enclosure shall be provided with certified crane lift points and forklift tine guides as follows:

3.5.8 QUANTITY OF LIFT POINTS. For design purposes, only 2 diagonally opposed lift points shall be considered to support the weight of the equipment, regardless of the total number of lift points used.

3.5.9 DESIGN LOAD. Vertical Design Load shall be taken as the base equipment weight plus 10%. The base equipment weight is what the assembled item weighs, as delivered, plus the maximum possible weight of all fluids or materials that the item is capable of containing when used as designed.

3.5.10 WORKING LOAD LIMIT. Working Load Limit (WLL) shall be calculated by multiplying the portion of the Vertical Design Load applied to each of the two diagonally opposed lift points by a factor of 1.155 (to account for a minimum rigging gear sling angle of 60° above horizontal). The WLL shall be used for all lift point design calculations and while based on only two lift points supporting the load, applied to each lift point installed.

3.5.11 LIFT POINT CALCULATIONS. The lift points, and the equipment structure to which the lift points are attached, shall be checked by a qualified engineer for adequacy per the requirements presented here. Analysis of the equipment structure shall also include buckling analysis per AISC, Allowable Stress Design methodology, as needed, to verify integrity of the structure, considering the loadings imposed by the orientation of the WLL as described herein. Calculations supporting the lift point design shall be submitted for review prior to acceptance of the equipment. Allowable stresses for the lift points shall be based on the following:

YS = Yield Strength (minimum)
UTS = Ultimate Tensile Strength (minimum)

$$F_{ALL} = MINIMUM\left[\frac{YS}{3} OR \frac{UTS}{5}\right]$$ (Allowable bending/tensile stress. Use the minimum value.)

$$\tau_{ALL} = \frac{F_{ALL}}{\sqrt{3}}$$ (Allowable shear stress)

$$\sigma_{BEARING} = 1.5 * \frac{UTS}{5}$$ (Allowable bearing stress based on projected area of shackle pin.)

3.5.3 LIFT POINT ORIENTATION. Orientation of lift points shall be such that when loaded, the direction of lifting load will be in the plane of the padeye plate ± 5°. Location of lift points shall be symmetrical with respect to the equipment center of gravity (CG). Lift points shall also be in a common horizontal plane above the CG. Location of lift points shall consider that each leg of lifting gear will be of equal length. The equipment shall lift level within 3°. If the equipment is intended to be stackable, provisions in the design shall be made to prevent damage to the lift points of the lower item if the upper item is not landed accurately or symmetrically. When lift points are installed on the supporting structure by welds that carry the lifted load, welding shall be performed and visually inspected in accordance with AWS D1.1.

3.5.4 LIFTING PROCEDURE. The equipment shall be capable of being lifted in its entirety without any disassembly and without degrading the weather resistance of the equipment enclosure (as specified in 3.4.4).

3.5.5 TINE GUIDE OPENINGS. The equipment shall be provided with box-section tine guides meeting ASME standards for forklifts, tine-guide openings in the base for safe handling and transport by forklift truck from each side. The box sections shall extend through the entire length or width of the equipment, completely enclosing the forklift tines. They shall be fabricated from heavy metal/channel having a definite thickness to withstand the stresses imposed. Box sections shall have internal cross-sectional dimensions of at least 6 inches high by 12 inches wide. Tine guide openings shall extend approximately 2 to 3 inches beyond the furthest outward point of the exterior of the enclosure. Center-to-center dimension of the tine guide openings shall not exceed 48 inches. Tine guides shall be centered about the unit's center of gravity. They shall be welded to the base and so spaced apart, center-to-center, that while transporting the equipment, a forklift truck can pass over pavement obstructions causing dynamic stresses representing five (5) times the equipment's weight without causing the box sections to fracture or part from the base.

3.5.6 CLEANING, TREATMENT AND PAINTING. The entire enclosure shall be painted. Surfaces to be painted shall be cleaned and dried to insure that they are free from scale, water, dirt, corrosion product, or any other contaminating substances. As soon as practicable after cleaning, and before any corrosion product or other contamination can result, the surfaces shall be prepared or treated to insure the adhesion of the coating system. The painting shall consist of at least one coat of primer and at least two finish coats of weather resistant exterior paint. The primer shall be applied to a clean, dry surface as soon as practicable after cleaning and treating. Painting shall be with manufacturer's current materials according to manufacturer's current processes and the total dry film thickness shall be not less than 2.5 mils over the entire surface. The final painted appearance shall be smooth and free from defects. Only lead-free and chromate-free materials shall be used.

3.6 LABELING REQUIREMENTS. The equipment shall be labeled as follows:

3.6.1 INSTRUCTION PLATES. Wording and numbers on all control panels, instruments, charts and plates shall be permanently and legibly displayed in bold face, English language characters on a contrasting background. Stencil the design load weight and "2000A" on at least one side of the enclosure.

3.6.2 CAUTION/WARNING PLATES. Corrosion resistant "Caution" or "Warning" plates shall be securely attached to the equipment in prominent, visible locations. All safety precautions to be observed by the operator or maintenance personnel shall be permanently marked on the plates.

3.6.3 IDENTIFICATION PLATE. A corrosion resistant identification plate shall be securely and conspicuously placed on the equipment. It may be the manufacturer's standard, but, as a minimum, it shall contain the following information:

3.6.3.1 Nomenclature.

3.6.3.2 Contractor's name.

3.6.3.3 Manufacturer's model designation.

3.6.3.4 Manufacturer's serial number.

3.6.3.5 Electrical characteristics (rated voltage, amperage, frequency, phases, etc).

3.6.3.6 Contract number.

3.6.3.7 Date of manufacture.

3.6.4 LIFT SKETCH DATA PLATE. A corrosion resistant data plate shall be securely and conspicuously placed on the equipment that provides a diagram of the proper lifting method for the equipment, including the design load weight of the equipment and rated load of each lift point.

3.6.5 TECHNICAL DATA. Provided technical data, written in the English language, shall contain, as a minimum, the following information:

3.6.5.1 General introductory information including pictures displaying the identity and location of components.

3.6.5.2 Specifics of "as built" circuit breaker and enclosure characteristics.

3.6.5.3 Technical manual for the main circuit breaker including theory of operation, instructions for operation and settings, and basic troubleshooting guidelines.

3.6.5.4 Listing of replacement parts with ordering information.

3.6.5.5 All required maintenance information.

3.6.5.6 Test data and documentation with certification signature(s) reflecting the satisfactory accomplishment of tests performed in paragraphs 4.2 and 4.4.

3.6.5.7 A schematic diagram of all electrical connections in the enclosure.

3.6.5.8 One or more CD-ROM or DVD-ROM disk(s) containing all technical data listed above in Adobe PDF format.

4 QUALITY ASSURANCE PROVISIONS. The contractor shall conform to quality assurance, inspection and testing criteria as follows:

4.1 RESPONSIBILITY FOR INSPECTION. The contractor shall be responsible for the performance of all inspection requirements (examinations and tests) as specified herein. The contractor shall be responsible for ensuring that the equipment provided meets all requirements of Section 3. The Government reserves the right to perform additional inspections and to reject the equipment provided if these inspections show that the equipment does not meet all requirements of Section 3.

4.2 TEST SCHEDULE COORDINATION AT ORIGIN. The contractor shall be responsible for coordinating testing schedules at the origin of the contracted work with the designated Contract Administration Office. Contact the receiving activity, through the Contract Administration Office a minimum of thirty (30) working days prior to performing the scheduled tests of paragraph 4.4, in order to provide the receiving activity the opportunity to observe the testing.

The contractor shall notify the Contract Administration Office along with a written copy of the notification to perform testing via the below contact information:
PSNS & IMF Bremerton
Code 270TS, Bldg 850, 5th Floor
1400 Farragut Avenue
Bremerton, WA 98314-5001

Code 270TS Electrical Temporary Services attn: Jason Seid
Telephone: (360) 476-7499; Fax (360) 476-5612
E-mail: jason.seid@navy.mil

Only supplies that completely conform to the specifications shall be offered for inspection and test. The contractor's test schedule shall allow consecutive inspection and test of the supplies offered. The Government reserves the right to charge the contractor for any Government re-inspection cost when supplies are not ready at the time requested by the contractor or when necessitated by prior rejection.

4.3 EXAMINATION. The equipment shall be examined to determine compliance with all requirements of this specification. The supplies offered for delivery shall be examined for design, construction, components, electrical equipment and workmanship to determine conformance with the requirements of this specification.

4.4 TESTS AT ORIGIN. At a minimum, the following tests shall be carried out by the manufacturer or manufacturer's representative prior to delivery of the equipment.

4.4.1 INSULATION RESISTANCE TESTS. Perform insulation resistance tests from each phase to ground using a calibrated 1000VDC megohmmeter on the input and output bus bars. The resistance between current carrying members and ground shall not be less than 500 megohms at any point tested. This test shall be performed a minimum of two (2EA) times, once prior to load testing and again following load testing.

4.4.2 OPERATIONAL TEST. Energize the input bus bars and monitor the output bus bar voltage. Manually cycle the circuit breaker no less than ten (10) times. Observe that the input voltage is present on the output bus bars with the breaker closed, is absent with the breaker open, and that the breaker operates smoothly.

4.4.3 SHUNT TRIP TEST. With the breaker energized and closed, use an external means to operate the shunt trip function and verify the breaker trips. Repeat this test no less than three (3) times.

4.4.4 LOAD TEST. Accomplish a load test as follows. During the test, observe that voltage drop from the input bus bars to the output bus bars does not exceed 1 VAC, that the current is balanced between phases when feeding a balanced load (difference < 5%), and that the equipment's internal temperature does not exceed safe operating levels.

4.4.4.1 Apply load in 20% increments until 100% of full load capacity is reached. Operate for a minimum of ten (10) minutes at each load step. Record output voltage, current and frequency at each step.

4.4.4.2 Operate the circuit breaker at 100% of full load for a period of at least three (3) hours.

4.4.4.3 While operating at full load, trip the breaker and verify satisfactory operation.

4.4.4.4 Following the load test, repeat examination of paragraph 4.3 and verify no damage occurred during the load test and full load trip.

4.5 LIFT POINT TESTING. Each lift point shall be load tested to 200% of WLL and held under load for 2 minutes. Acceptance criteria shall be: no bending, cracking, or permanent deformation of the lift points or associated supporting structure. Documentation shall be provided on the fabricator's company letterhead stating that each lifting pad has successfully passed the 200% test. The fabricator shall mark the lift points in a permanent manner with the WLL, test date, and test load applied. All weights shall be marked in pounds.

4.6 TEST AND EVALUATION REPORT. A test and evaluation report shall be prepared by the contractor documenting all readings and results that were recorded during the performance of paragraphs 4.2 and 4.4, including any defects found, repairs that were made and documentation of the subsequent retesting. This test and evaluation report shall be provided to the Government along with the equipment.

4.7 WARRANTY. Contractor shall provide a warranty period in writing covering all parts and labor associated with the repair of the circuit breaker. When possible, all repairs covered by warranty shall take place on site. Warranty shall commence from the date of acceptance of the circuit breaker. Warranty period shall be no less than three (3) years from date of acceptance.